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What Is Sound?

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Whenever we hear a sound, sound waves from some object are reaching our ears. How does an object produce waves? How do sound waves travel? We will try to answer these questions.

All sounds are produced by different objects that are vibrating. When we pluck a guitar string, for example, we make it vibrate. As it vibrates, the string sends out sound waves. A stereo speaker produces sound waves when a paper cone in the speaker vibrates. When we talk or sing, vocal cords in our voice box vibrate.

Sound waves reach our ear by traveling through a medium. Often the medium is air, a mixture of gases. But sound waves can also travel through solids and liquids.

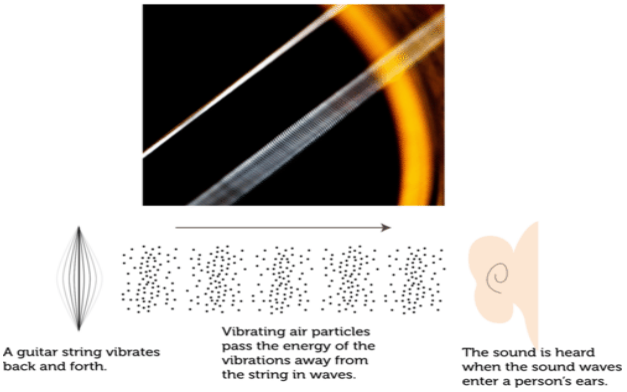

Figure 1: Guitar String Vibration

Sound waves are longitudinal waves that can go through all states of matter. We vibrate the end of the spring in the direction of the waves. The waves, a series of compressions and rarefactions, travel from that end of the spring to the other.

Figure 1 shows how a vibrating guitar string sends sound waves and how we hear it. All matter made of molecules. When the string vibrates to the right, molecules crowd together into a compression. Each molecule collides with a molecule to its right. As a result, the compression moves to the right. As the string vibrates to the left, it leaves a space. Molecules spread out in the space, forming a rarefaction [1].

Sound waves transfer the energy of a vibrating object to our ear. Actually, it is the molecules of the medium that transfer the energy by colliding with each other. The transfer of energy continues when the sound waves reach your ear.

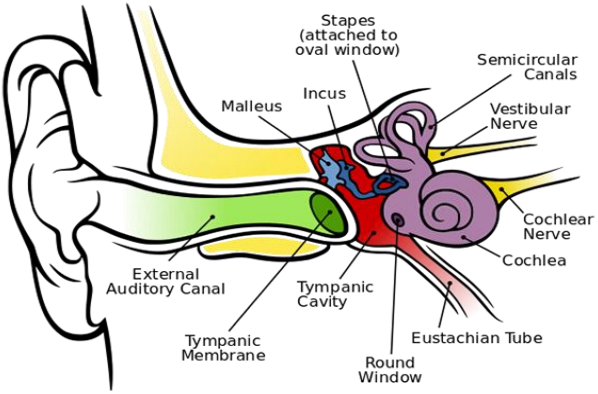

Figure 2: Anatomy of the Ear

Figure 2 shows the sections of our ear. Sound waves enter the outer ear. They travel through the air in the ear canal. The sound waves hit a thin membrane, the eardrum, at the end

of the canal. The eardrum vibrates. It sends, or transmits, the sound waves to three small bones in the middle ear. The bones vibrate. One of them, the stirrup, vibrates against the oval window, a thin membrane over the inner ear. The oval window vibrates and sends the sound waves into a liquid-filled chamber of the inner ear. The sound waves are converted to coded signals that are sent by nerves to the brain. The latter interprets the signals as sounds [2].

Sounds have many differences. We can hear one difference by stroking our hand along a piano keyboard from left to right. How do the sounds differ from key to key? They get higher. If we play the keys from right to left, the sounds get lower (or deeper). The highness or lowness of a sound is called pitch. We hear differences in pitch when singers reach for high notes, or when a record slows down.

If you carry out an experiment with a baseball card and a bicycle, you will investigate how pitches change. First of all, attach the card to the back of the bicycle so that the card hits the spokes when you turn the wheel with your hand. As you turn the wheel, the card vibrates and makes a sound. The faster you turn the wheel, the faster the card vibrates and the higher the pitch becomes. Pitch depends on the frequency of sound waves. When the card, or any object, vibrates faster, it produces more waves per second. These waves have higher frequencies. The higher the frequency, the higher the pitch.

The frequencies of sound waves are measured in hertz (Hz). People, in general, can hear sound waves with frequencies of about 20 Hz to 20,000 Hz. In fact, most people cannot hear infrasonic waves. They are pressure variations in the air at frequencies in the range of 20 Hz and below. Nor can most people hear ultrasonic waves, sound waves with frequencies above 20,000 Hz. A lot of animals can hear frequencies that people cannot hear at all. For instance,

dolphins, white whales, guinea pigs, and bats can hear frequencies higher than 100,000 Hz [3].

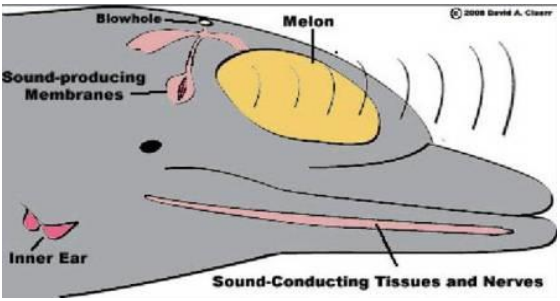

Figure 3: How Dolphins Hear

Another way you can hear how sounds differ is to hit one piano key harder and harder. The more energy you use to make a sound, the louder the sound becomes. The loudness, or volume, of a sound depends on the amplitude of sound waves. When you use more energy to make a sound, you produce sound waves with greater amplitude. The greater the amplitude, the louder the sound.

The volume of a sound is measured in units called decibels (dB). Sounds above 90 dB can cause temporary hearing loss. People who work near loud noises must wear protective devices over their ears.

References:

1. What is Sound? [Electronic resource]. – Mode of access: http://www.open.ac.uk/. – Date of access: 13.03.2020.
2. Sound [Electronic resource]. – Mode of access: https://www.soundproofingcompany.com/. – Date of access: 27.02.2020.
3. How Do Dolphins Hear? [Electronic resource]. – Mode of access: https://se7en-ila.livejournal.com/. – Date of access: 14.03.2020.